CLAIMS:

1. An image processing method of extracting the points of a path following a threadlike structure in an image formed by a grid of Potential points, comprising :

a first processing step of performing a first path-tracking operation using a front marching technique denoted Filiation Front Marching Technique for supplying at least one First Track formed by succeeding points denoted Fathers and corresponding Children of the threadlike structure by marching a Front of points forwards starting at a predetermined Start point until a predetermined End point of said grid is reached,

and a second processing step of performing a second path-tracking operation using said Filiation Front Marching Technique for supplying a Best Path from one First Track by back propagating the Front starting at the End-Point and going through already determined Children and corresponding Fathers until the Start Point is reached.

2. A method as claimed in Claim 1, wherein, for performing the first path-tracking operation, the Front Marching Technique propagates the Front forwards when the following conditions are satisfied for selecting a second point denoted Child to succeed a first point denoted Father of the grid to form a First Track, said conditions comprising:

a law of location for the Father which must already pertain to the Front, and a criterion of cost for said Father referred to as Cumulated Cost, which must be minimal compared to other points of the Front,

a law of location for the Child, which must be on the same row or column of the grid (City Block Distance) as the Father with one grid point interval, and a criterion of cost referred to as Cumulated Cost for said Child including a term of the minimum among the Cumulated Costs of the succeeding points already selected from the Start Point to said Father and a term of the Potential at said Child,

a law of filiation according to which said determined Child becomes a possible further Father of the Front for further forwarding the Front.

3. A method as claimed in Claim 2, wherein :

the function of Cumulated Costs ($CC_k$) to associate to a current point referred to as Child is calculated as follows as a Potential Mean Value (1) :

$$CC_k = \frac{1}{L_k} \sum_{j=1}^{j=k} Q_j \qquad (1)$$

where $Q_j$ are the Potentials at the current points located between the Start Point and said current point ($P_k$), and $L_k$ is the length of the path between the Start Point and the Father of said Child calculated using a City Block Distance Law.

4. A method as claimed in Claim 3, wherein :

the length of the path between the Start Point and the current point referred to as Child is calculated using the City Block Distance Law by adding 1 each time a Father fathoms a Child, so that when the Father is located at a determined Distance ($L_k$) from the Start Point, the Child ($P_k$) is located at an updated Distance, which is said Distance of the Father plus one unity ($L_k+1$, $L_{k+1}$) and so that the function of Cumulated Costs ($CC_k$) to associate to said Child may be written according to relation (2):

$$CC_k = \frac{(CC_{k-1})(L_{k-1}) + Q_k}{L_k} \qquad (2)$$

which is a function of Cumulated Cost for the Child calculated from the function of Cumulated Cost of the Father ($CC_K$), the Potential at the Child ($P_K$) and the Distance from the Start Point to the Father ($L_{K-1}$).

5. A method as claimed in Claim 4, wherein :

the function ($CC_k$) of Cumulated Cost to attribute to a current point referred to as Child is calculated using an average effected on predetermined limited temporal spans which permits of taking Local Events into account.

6. A method as claimed in Claim 5, wherein :

calculating the function ($CC_k$) of Cumulated Cost using an average effected on predetermined limited temporal spans is obtained using one parameter $\alpha$ which is a weight factor progressively minimizing the influence of points situated farther away than at a given distance from the current point so that said function ($CC_k$) of Cumulated Costs is given by the following relation (3) :

$$CC_K = \alpha CC_{K-1} + (1-\alpha) Q_K \qquad (3)$$

where the weight factor $\alpha$ is a constant and fixes the temporal span, and the number of Fathers which is taken into account, where $CC_{K-1}$ is the function of Cumulated Costs related to the Father and $Q_K$ is the Potential at the current point.

7. A method as claimed in Claim 6, wherein :
the span may be approximated by the relation :
$1/(1-\alpha)$ where $0 < \alpha < 1$. (4)

8. A method as claimed in one of the ~~Claims 5 to 7;~~ claim 1 wherein :
besides taking Local Events into account, the Filiation Front Marching technique also takes Global Events into account and to that end, takes into account the curvature value at the current point along the First Track, said curvature ($K_K$) being derived from a Turning Angle value which is defined as the angle between the tangent to the track at the current point and a reference axis so that a term based on the curvature value is taken into account to calculate the function ($CC_k$) of Cumulated Costs in order to penalize track trajectories having too many points associated to important curvature values.

9. A method as claimed in Claim 8, wherein :
from the curvature ($K_k$), and from a weight factor (W) which takes the potential at the current point and said curvature into account, the function ($CC_k$) of Cumulated Costs is provided by the following recursive relation :

$$CC_K = \alpha\ CC_{k-1} + (1-\alpha)\ [Q_k + W.K_k] \quad (10)$$

where $CC_k$ is a function of local measures and of global measures.

10. A method as claimed in ~~any of the preceding Claims;~~ claim 1 comprising :
an operation (1) of image data acquisition from an Original Image (OI) representing a threadlike structure on a background, said image data including digital intensity levels, and pixel coordinates in the Original Image ;
an operation (2) of constructing an Image of Potentials (IP) in which each pixel of the Original Image (OI) is associated to a Potential forming a grid of points ;
and, performed in said Image of Potentials :
an initializing phase (3) of setting end points including a Start point (A) and an End point (B) between which a path following the threadlike structure is to be determined ;

a first processing phase (4) of front propagation, using the Filiation Front Marching (FFM) technique, to march the front from the start point A to the end point B ;

a second processing phase (5) also using the Filiation Front Marching technique (FFM), starting from the End Point (B) towards the Start Point (A), propagating backwards from each Child to the corresponding Father until the Start Point A is reached.

11. A method as claimed in Claim 10, wherein :

the operation (2) of constructing a contrast image IP for associating each pixel of the Original Image to a new calculated intensity level which is taken as a Potential, comprising, in an Original Image where the objects of interest, among which the threadlike structure, are darker than the background : an operation of inversion of the intensity levels ; a filtering operation of evaluation of the ridgeness ; and an operation of further inversion to provide an image of Potentials where the objects of interest are again darker than the background and form thin troughs substantially contrasting on the background.

12. An image processing method of performing a path-tracking operation to extract points of a threadlike structure in an image formed of a grid of Potential points, using a front marching technique denoted Filiation Front Marching Technique for supplying at least one Track formed of succeeding points denoted first points (Fathers) and corresponding second points (Children) of the threadlike structure by marching a Front of points forwards comprising steps of :

setting predetermined Start and End Points in said grid,

propagating the Front forwards between the Start and End Points

when the following conditions are satisfied for selecting a second point (Child) to succeed a first point (Father) of the grid to form the Track, said conditions comprising:

a law of location for the first point (Father) which must already pertain to the Front, and a criterion of cost for said first point (Father) referred to as Cumulated Costs which must be minimal compared to the Cumulated Costs of other points of the Front,

a law of location for the second point (Child), which must be on the same row or column of the grid (City Block Distance) as the first point (Father) with one grid point interval, and a criterion of cost referred to as Cumulated Costs for said second point (Child) which must be minimal compared to cumulated Costs obtained with other possible first points (Fathers),

a law of filiation according to which said determined second point (Child) becomes a possible further first point (Father) of the Front for further forwarding the Front, said Cumulated Costs including a term of the minimum among the Cumulated Costs of the succeeding points already selected from the Start Point to a so-called first point and a term of the Potential at a so-called second point.

13. A system comprising a suitably programmed computer or a special purpose processor having circuit means, which are arranged for processing image data according to the method as claimed in ~~any of the preceding Claims.~~ claim 1

14. An apparatus having means for acquiring medical image data, having a system as claimed in claim 13 which has access to said medical digital image data, and having means for displaying the processed images.

15. A computer program product comprising a set of instructions for carrying out a method as claimed in one of ~~Claims 1 to 12.~~ claim 1